

Amendment After Notice of Allowance Under 37 C.F.R. §1.312

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Serial No.: 10/804,968

Confirmation No.: 7863

Filed: March 18, 2004

For: DISTANCE OF FLIGHT SPECTROMETER FOR MS AND SIMULTANEOUS SCANLESS MS/MS

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Amendments to the Specification

Please replace the paragraph beginning at page 1, paragraph [0002], with the following amended paragraph.

The present invention relates to a mass spectrometer for mass spectrometry (MS) based on ion flight distance in a given time being related to its ~~mass-charge~~ mass-to-charge ratio. This has the advantages of time-of-flight mass spectrometry without the high-speed electronics normally required. The mass spectrometer may be in a tandem configuration to effect simultaneous collection of precursor and product spectra.

Please replace the paragraph beginning at page 10, Fig. 7, with the following amended paragraph.

Fig. 7 shows a graphical representation of distance of flight versus ion  ~~$m/z$~~   $m/z$  when using constant momentum extraction;

Please replace the paragraph beginning at page 11, paragraph [0033], with the following amended paragraph.

The batch of ions from the ion pulser enters a field-free region in the third vacuum chamber. The pulse of ions 26 may contain ions of several  ~~$m/z$~~   $m/z$  values. This is illustrated by the different size circles. In the case of a constant extraction pulse from the preceding ions store and pulse apparatus, the ions will all have roughly the same energy. Their velocity will then be a function of their  $m/z$  with the lower value  ~~$m/z$~~   $m/z$  ions having a higher velocity than ions with higher values of  $m/z$ . By the time the ions reach the orthogonal field extraction plate 27, they will be dispersed according to their  $m/z$  values. An extraction pulse is then applied between the

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extraction plate 27 and grid 28 to provide an orthogonal force to the ions in this region. The timing of the extraction pulse relative to the ion pulsing from the ion store and pulse apparatus is carefully controlled so that the ions of interest are in the orthogonal extraction region at the time of the extraction pulse. If ions of differing  $m/z$  have the same axial kinetic energy from the pulser, they will have roughly parallel paths as they travel through the extraction grid and beyond as shown. Once through the grid, the ions are detected by an array of detectors 29 located on the other side of the grid. The position of the detectors is linearly related to the position of the ions where they are deflected. The angle of the detector array is a designer option. The ion intensity of ions with different  $m/z$  ratios will be detected by different elements of the array. Interrogation of the array elements will then provide the information from which a mass spectrum can be constructed.

Please replace the paragraph beginning at page 18, paragraph [0048], with the following amended paragraph.

An alternative way to attain linearization and compaction of the  $m/z$  values as a function of distance of flight is to apply an added extraction region just beyond the extraction region contained in the store and pulser device. The field strength in this second extraction region would increase with time following the onset of extraction so that the ions with higher values of  $m/z$  emerging from the source later than ions with smaller  $m/z$  are subjected to a higher extraction field than the lower  $m/z$  ions that preceded them. The inset in Figure 6 shows the possible time-dependent value of such an added extraction voltage. The time-dependence shown will result in a linear relationship between the detector distance and the ~~charge to mass~~ mass-to-charge ( $m/z$ ) ( $m/z$ ) values of the detected ions.

Please replace the paragraph beginning at page 25, paragraph [0071], with the following amended paragraph.

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The ion flight time is solely a function of the product ion  $m/z$  since all ions are orthogonally extracted at the same time but with  $m/z$ -dependent velocities. An ion's axial distance depends on the precursor ion velocity and the total flight time. A derived plot of the total flight time and axial distance for products of three different precursor ion  $m/z$  values is shown in Figure 10.

Please replace the Abstract beginning at page 38 with the following amended Abstract.

DISTANCE OF FLIGHT SPECTROMETER FOR MS AND SIMULTANEOUS  
SCANLESS MS/MS

ABSTRACT OF THE DISCLOSURE

A distance of flight (DOF) approach to mass ~~spectroscopy~~ spectrometry in which the resolution among the various ion masses is accomplished in space rather than time. A separate detector is associated with each ion mass resolution element. The DOF mass spectrometer can serve as one element in a tandem arrangement which has the capability to produce a full two-dimensional precursor/product spectrum for each bunch of ions extracted from the source. A "distance of flight" (DOF) mass analyzer is used in combination with time-of-flight (TOF) mass analysis for precursor and product dispersion. All the precursor ions can undergo a mass changing reaction simultaneously, while still retaining the essential information about the particular precursor  $m/z$  value from which each product ion  $m/z$  value emanated. Through the use of a two-dimensional detector, all the products ions from all the precursors can be detected for each batch of ions analyzed.